Novel catalyst systems for deNO$_x$

David W. J. McClymont, Stan T. Kolaczkowski, Kieran C. Molloy, Serpil Awdry
Centre for Sustainable Chemical Technologies, University of Bath, BA2 7AY, UK.

E-mail: D.W.J.McClymont@bath.ac.uk URL: http://www.bath.ac.uk/csct

What is NO$_x$?

Nitric oxides are highly reactive gases; primarily NO (>90 %) and NO_2, involved in many pollutant processes *e.g.* the formation of acid rain

They are produced as a result of high temperatures during the combustion of fuels and legislation is in place to control emissions *i.e.* the European Waste Incineration Directive (WID) regulates activities that involve burning or gasification of waste (Figure 1)

Technologies have been developed which react a reductant with NO_x emissions, forming harmless N_2 and H_2O. Development of a material and process to treat NO_x emissions using H_2 is the aim of this project

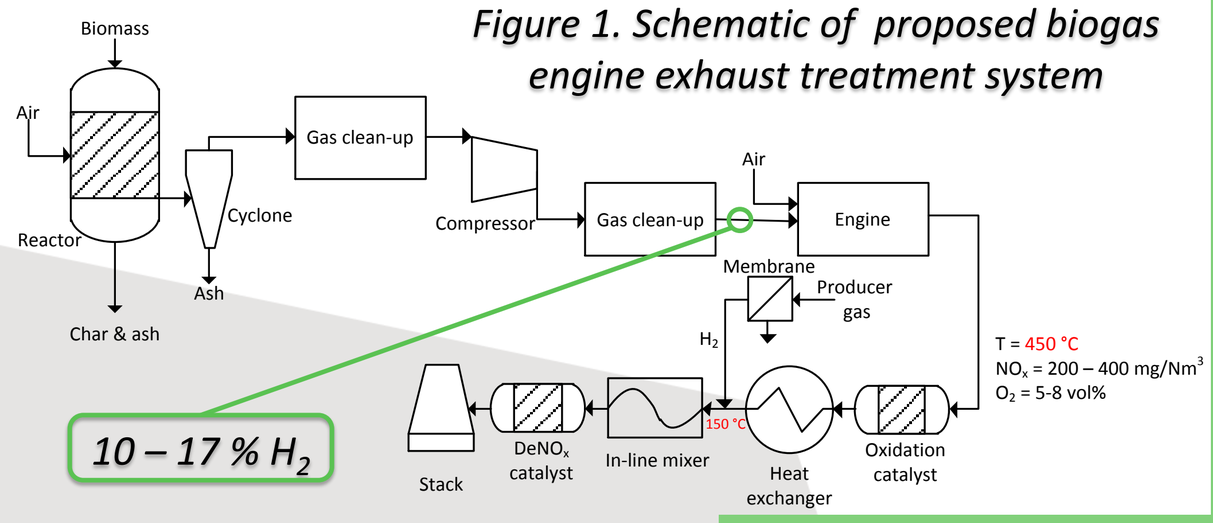

Figure 1. Schematic of proposed biogas engine exhaust treatment system

H_2 for deNO$_x$

Measurements made on an operational gasification plant (Figure 2), using a mass spectrometer (Figure 5), identified the fuel produced as having a 10-17 % H_2 content depending on the conditions in the gasifier

Utilising H_2 already present in the system (Figure 1) can save on the associated costs of using additional chemicals, as in the current processes (*i.e.* NH_3 – selective catalytic reduction (SCR))

H_2 can also be used in NO_x storage and reduction (NSR) processes where NO_x species are 'trapped' before they are subsequently reduced through alternate lean and rich-burn cycles

Target chemistry : **$2NO + 2H_2 \rightarrow 2H_2O + N_2$** **$2NO_2 + 4H_2 \rightarrow 4H_2O + N_2$**

Figure 2. Refgas gasification plant

Catalysts

Catalysts prepared using impregnation techniques (Table 1)

Supported on honeycomb monoliths (Figure 3)

Outer diameter = 14 mm

Channel size = 1 mm x 1 mm (~80 channels per monolith)

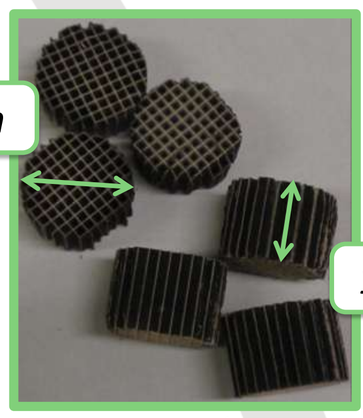

Figure 3. Pt/Al_2O_3 monoliths

Table 1. Summary of prepared H_2-deNO$_x$ catalysts and associated processes

H_2-SCR	H_2-NSR
Pt/Al_2O_3	$Pt/Ba/Al_2O_3$
Ag/Al_2O_3	$Pt/K/Al_2O_3$
	$Ag/Ba/Al_2O_3$
	$Ag/K/Al_2O_3$

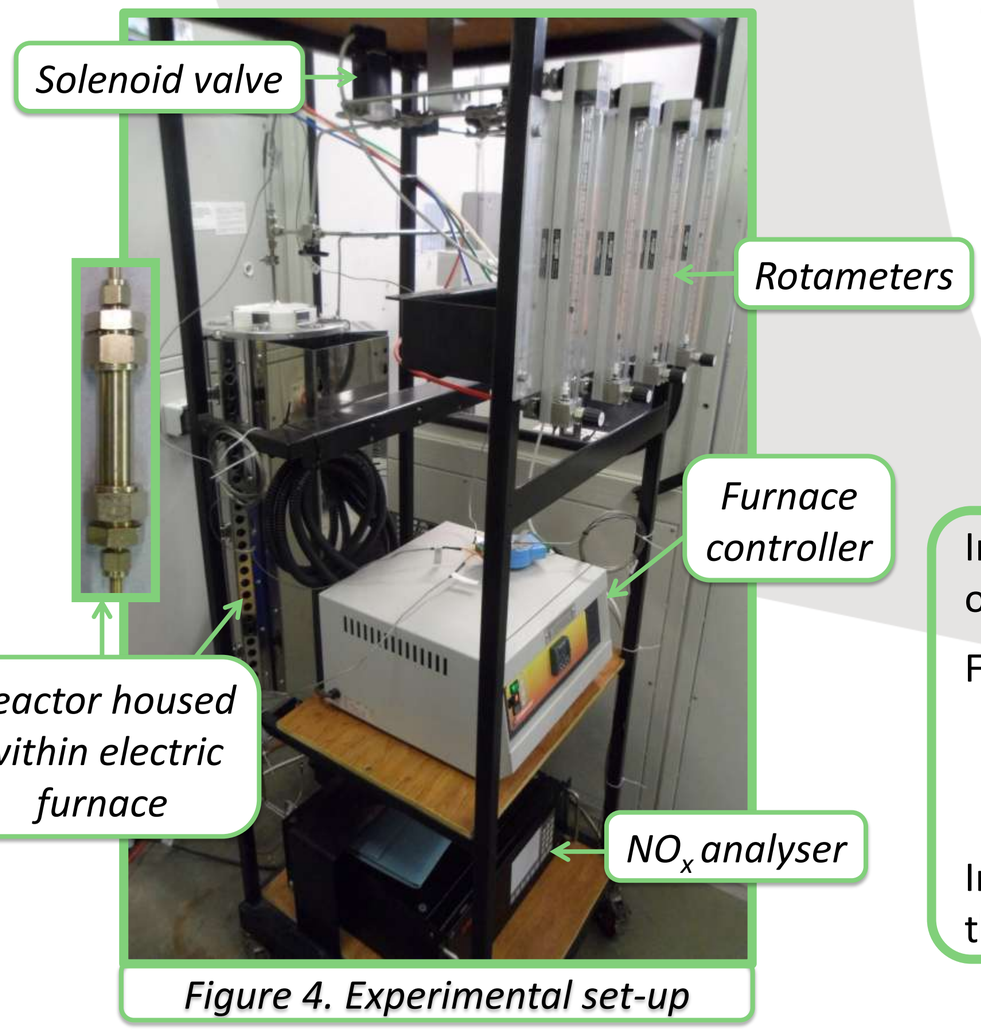

Figure 4. Experimental set-up

Experimental set-up

A rig for investigating catalyst performance in the different processes has been designed, built and commissioned (Figure 4)

A method for identifying the products of the catalytic reactions, using an online mass spectrometer (Figure 5), has been developed and tested

Figure 5. Hiden mass spectrometer

Future work

Investigate prepared catalysts performance in their relevant processes and identify optimum conditions/limitations with relevance to the final application

Further characterize catalysts through temperature-programmed studies:

- Temperature-programmed desorption
- Temperature-programmed surface reactions

Investigate hybrid design; combination of both NSR and SCR processes, using H_2 as the reductant

Centre for Sustainable Chemical Technologies

UNIVERSITY OF BATH

EPSRC Pioneering research and skills